DoD - NIOSH Particulate Matter Research Workshop Meeting Proceedings

6-7 September 2005

DoD - NIOSH Particulate Matter Research Workshop
Meeting Proceedings, 6-7 September 2005

Contents

1. Background……..…..4

2. Purpose and Objectives…….……..…...4

3. Objective 1: Review Current Knowledge Concerning Particulate Matter Health Hazards in General……..…....5

4. Objective 2: Review the Sources and Types of Data from the Iraqi Theater….……..7

5. Objective 3: Review Other Surveillance Data…….…..9

6. Objective 4: Provide Constructive Criticism on Proposed Approaches to Fill Data Gaps……..……...11

7. Objective 5: Identify Data Needs and Gaps for Conducting Particulate Matter Health Risk Assessments (Hazard Identification, Dose-Response, Exposure Assessment, Risk Characterization)…….…….14

8. Objective 6: Recommend a Strategy for Presentation to the Chair, Joint Particulate Matter Work Group……..16

9. Next Steps…….17

Glossary of Acronyms…….…..18

Appendices

A. Particulate Matter Work Group Charter

B. DoD - NIOSH Particulate Matter Research Workshop Meeting Agenda

C. DoD - NIOSH Particulate Matter Research Workshop Meeting Roster

D. "Opening Remarks: Particulate Matter Workshop," Dr. Paul Knechtges

E. "Toxicity of Ultrafine Particles," Dr. Vince Castranova

F. "Particulate Matter Standards and Health Effects," Dr. Coleen Baird Weese

G. "The Physical, Biological and Chemical Characterization of Micro-particulates from the Middle East," CDR Mark B. Lyles

H. “Routine Ambient Air Surveillance in the USCENTCOM AOR,” Dr. Jack M. Heller

I. “Health Effects on Indigenous Populations,” Dr. Donald J. Goodwin

J. “Particulates and Health Bibliography,” by Dr. Donald J. Goodwin

K. “Deployment Health Surveillance Data Sources,” Dr. Michael Kilpatrick

L. “Inhalation Injury: Pulmonary Pathology Analysis of Soldiers,” Dr. Teri J. Franks

M. “Dust Load in Autopsied Soldiers (Iraq 2003),” Dr. Val Vallyathan

N. “Enhanced Surveillance Sub-Group, Particulate Matter Working Group,” Dr. Jack M. Heller

O. “Proposed Particulate Matter Toxicity Studies,” LT Erin Wilfong

DoD - NIOSH Particulate Matter Research Workshop
Meeting Proceedings, 6-7 September 2005

1. BACKGROUND

a. Particulate Matter Work Group Charter (Appendix A). On 18 January 2005, the Assistant Secretary of Defense (Health Affairs) chartered the Joint Particulate Matter Work Group to assess current Department of Defense (DoD) activities to identify the potential health issues associated with particulate matter exposure and to determine the potential use of particulate matter as a carrier of chemical and biological warfare agents. To achieve the objectives of the work group, subgroups were formed to research and report on three major topic areas, including the Health Effects Research Subgroup, chartered to identify knowledge gaps where research studies on the health effects associated with particulate matter exposure could be helpful.

b. DoD - NIOSH Particulate Matter Research Workshop Meeting Agenda and Roster (Appendices B and C). On 6-7 September 2005, the Health Effects Research Subgroup held a workshop at the National Institute for Occupational Safety and Health (NIOSH) Health Effects Laboratory Division (HELD) in Morgantown, West Virginia. The goal of the meeting was to ensure sufficient data were available to make evidence-based recommendations to commanders regarding the potential health risk of particulate matter, including enhanced surveillance, control strategies (e.g., shortened rotations), specific health evaluations or general recognition and awareness without specific actions.

2. PURPOSE AND OBJECTIVES

a. "Opening Remarks: Particulate Matter Workshop," Dr. Paul Knechtges (Appendix D)

(1) Dr. Knechtges, U.S. Army Medical Research and Materiel Command (USAMRMC), outlined the objectives of the workshop based on the first three steps of the data quality objectives (DQO) process used by the Environmental Protection Agency:

- Step 1: State the Problem.
- Step 2: Identify the Decision.
- Step 3: Identify the Inputs to the Decision.

(2) Step 3, the inputs (data) needed to assess the risks of particulate matter to deployed personnel, were the primary focus of the workshop. The types of data to be reviewed during the workshop were programmatically categorized as:

- Basic Research (experimental research).
- Research, Development, Testing, and Evaluation (RDT&E; technology development).
- Studies and Analysis (observational research).
- Surveillance and Monitoring (collectible and actionable data).

b. Objectives. There were six specific objectives of the workshop:

(1) Review current knowledge concerning particulate matter health hazards in general.

(2) Review the sources and types of data from the Iraqi Theater.

(3) Review other surveillance data.

(4) Provide constructive criticism on proposed approaches to fill data gaps.

(5) Identify data needs and gaps for conducting particulate matter health risk assessments (hazard identification, dose-response, exposure assessment, risk characterization).

(6) Recommend a strategy for presentation to the Chair, Joint Particulate Matter Work Group.

3. OBJECTIVE 1: REVIEW CURRENT KNOWLEDGE CONCERNING PARTICULATE MATTER HEALTH HAZARDS IN GENERAL.

a. "Toxicity of Ultrafine Particles," Dr. Vince Castranova (Appendix E)

(1) Dr. Castranova, NIOSH, discussed the toxicity of ultrafine particles. He defined coarse (>2.5 μm), fine (0.1-2.5 μm), and ultrafine (<0.1 μm) particles and discussed the formation of these particles, presenting a chart relating deposition in the respiratory system as a function of particle sizes ranging from 0.01-100 μm.

(2) Focusing on ultrafine particles, Dr. Castranova stated:

- Although ultrafine particles are formed from nucleation of pollutants generated by human activity, some recent evidence suggests that ultrafine particles may exist in natural or field environments.
- Recent publications demonstrated that a high fraction of inhaled ultrafine particles are deposited in the lung.
- Ultrafine particles move from the alveolar space to the lung interstitial space, where they can cause inflammation, and possibly translocate from the lung to systemic sites.
- Evidence suggests that ultrafine particles may also cross the skin barrier.
- The toxicity of ultrafine particles is higher per unit mass unit compared with fine particles, but toxicity is clearly better dose-related to the increasing surface area of fine and ultrafine particles.
- The toxicity of ultrafine particles may be complicated by particle disaggreation of agglomerates, which is dependent upon the particles' characteristics.

b. "Particulate Matter Standards and Health Effects," Dr. Coleen Weese (Appendix F)

(1) Dr. Weese, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), reviewed the current U.S. particulate matter standards and their health basis, as well as some of the levels measured in deployed settings.

- "Particulate matter" is the generic term for a broad class of physically and chemically diverse substances that exist in ambient air as discrete particles (liquid or droplets) over a wide range of sizes.
  - These particles originate from a variety of stationary and mobile sources to include natural dirt, dust and sand, and industrial and motor vehicle emissions.
  - Physical and chemical properties vary greatly with time, region, meteorology and source category.
- Particulate matter is currently addressed by the National Ambient Air Quality Standards (NAAQS) under the Clean Air Act.
- The current NAAQS include a PM 10 (particulate matter 10 microns or less in diameter) 24-hour level of 150 $\mu g/m^3$, as well as an annual average of 50 $\mu g/m^3$.
- The NAAQs for PM 10 (annual) were used as the basis of the PM 10 long-term Military Exposure Guideline (MEG) level.
  - Originally, the long-term MEG for particulate matter was less conservative, 70 $\mu g/m^3$, largely related to the consideration that military personnel are more fit than the general public and does not include sensitive subgroups.
  - Currently, the long-term MEG is identical to the PM 10 NAAQS, since available literature did not support a precise differentiation. While the annual average is a composite of high and low days, it is not typically feasible to provide pre-cautionary statements based on daily levels as the Environmental Protection Agency (EPA) currently does, due to the time lag for analysis. Particulate levels measured as PM 10 in shift weighted average (SWA) routinely exceed the long-term MEGs (84 percent (1408/1672) of samples).

(2) Dr. Weese presented the matrix used for determining operational risk based on the severity and probability of the threat, which is most closely aligned with impacts to mission capability and unit readiness. Apart from perhaps acute asthmatic exacerbations or cardiac conditions which render a soldier unable to perform duties, it is unclear to what degree rising particulate levels may impact unit readiness or mission capability. Under the NAAQs, the EPA considers 425 $\mu g/m^3$ to be the "hazardous" level. This level is currently used to identify marginal risk for operational risk management. However, the EPA uses this value as a 24-hour value, not a multiple day average. Because scientific information on particulate matter toxicity is incomplete, the EPA has typically made the assumption of equivalent potency across particle types. These considerations have bearing on the interpretation of health effects associated with particulate matter levels in SWA.

4. OBJECTIVE 2: REVIEW THE SOURCES AND TYPES OF DATA FROM THE IRAQI THEATER.

a. "The Physical, Biological and Chemical Characterization of Micro-particulates from the Middle East," CDR Mark B. Lyles (Appendix G)

(1) CDR Lyles, Naval Institute for Dental and Biomedical Research (NIDBR), presented background information and data from his 2004 study of particulate matter in the U.S. Central Command's Area of Responsibility (CENTCOM AOR).

(2) CDR Lyles:

- Discussed local temperature and humidity conditions.
- Presented charts with measured hourly mean (n = 12 days) concentrations of ambient airborne particulate matter (>0.5 µm to ≤ 10 µm; and 5.0 µm to 10 µm ranges) for several base camps.
- Presented charts with hourly air sample results from several base camps for 12 different days.
- Presented detailed chemical analyses of Iraqi and Kuwaiti soils as a series of tables and charts with the following conclusions:
  - As particle size decreases, the percentage of heavy metals increases.
  - The concentrations of metals were at or near the maximum inhalation levels for several metals.
  - Significant daily loading of metals is possible.
- Presented detailed microbial analyses of Iraqi and Kuwaiti soils as a series of tables and charts. A number of bacteria and fungi of disease importance were identified in the soils. His conclusions included the following:
  - A relatively abundant microbial community exists in the dust, including PM_{10} particles.
  - Hemolytic and antibiotic resistant strains have been isolated/characterized.
  - Microbial identification schemes cause uncertainty in speciation.
  - Methods bias perspective of microbial community depending on database use.
  - The need exists for a defensible trigger for health-risk concern.

b. Discussion Following CDR Lyles's Presentation.

Discussion included:

- The significance of dust measurements versus inhaled fractions of particles.
- The difference between inhalable fraction versus respirable fraction in that environment.
- The medical significance of finding pathogens in dust fractions, a natural reservoir for many pathogenic and opportunistic bacteria.
- Why the Genus *Acinetobacter*, which are implicated in infections among wounded soldiers, were not identified in the dust fraction analyses. CDR Lyles indicated microbial analysis had not been completed and Genus *Acinetobacter* may yet be identified.

- *Bacillus cereus*, also called the "cereal bacterium," which is very common in the soil and in grain foods.

c. "Routine Ambient Air Surveillance in the USCENTCOM AOR," Dr. Jack M. Heller (Appendix H)

(1) Dr. Heller, USACHPPM, began his presentation by providing background on the requirements to conduct and document Occupational and Environmental Health Surveillance (OEHS) during military deployments:
- Samples are routinely collected from soil, water and air at locations where U.S. personnel are deployed.
- The two most common types of air samples collected are particulate matter and volatile organic compounds (VOCs).
- Particulate matter samples have been taken historically:
  - During the 1991 oil well fires following Operation Desert Storm.
  - From November 2001 to the present during Operation Enduring Freedom (OEF).
  - From March 2003 to the present during Operation Iraqi Freedom (OIF).
- The MEGs for PM_{10} and $PM_{2.5}$ are 150 $\mu g/m^3$ per 24 hours (50 $\mu g/m^3$ per 1-year) and 65 $\mu g/m^3$ per 24 hours (15 $\mu g/m^3$ per 1-year), respectively.
  - During OEF, the average concentration of PM_{10} in Afghanistan was 350 $\mu g/m^3$ with a maximum concentration of 3,210 $\mu g/m^3$ (n = 130).
  - During OIF, the average concentration of PM_{10} in Iraq was 340 $\mu g/m^3$ with a maximum concentration of 46,500 $\mu g/m^3$ (n = 1,088). The average $PM_{2.5}$ concentration was 70 $\mu g/m^3$ with a maximum concentration of 290 $\mu g/m^3$ (n = 66).

(2) Dr. Heller concluded that routine surveillance indicates particulate matter represents the most significant exposure in the CENTCOM AOR. He also stated that PM needs to be better characterized, the objective of the proposed Enhanced Surveillance.

d. "Health Effects on Indigenous Populations," Dr. Donald J. Goodwin (Appendices I and J)

(1) Dr. Goodwin, Air Force Research Laboratory (AFRL), presented a historical overview of air pollution and health beginning with the Roman Empire. Most historical air pollution episodes resulted from industrial or urban air sources of pollution. Although published reports of desert lung diseases are limited, some particulate matter-related pulmonary diseases among desert inhabitants have been documented.
- Beginning in the 1950s, it was noted that silica dust can be deposited in the lungs without causing fibrogenic activity.
- "Desert Lung" is a nonoccupational dust pneumoconiosis presenting as micronodular dense shadows on chest x-rays in asymptomatic patients. During Desert Storm, one author attributed fine particulate matter (< 1 μm) in sand to be related to a hypersensitive allergic reaction in the lungs.

- A survey of combat troops from Desert Shield demonstrated that sore throat and cough, as well as rhinorrhea were common. Two percent of troops claimed that upper respiratory symptoms were significant enough to interfere with their duties.
- Multiple allergens have been documented in the sand.

(2) Relationships between sand storms and mortality have been demonstrated in Korea, China and Taiwan. Mortality risk appears to be more closely associated with fine than coarse particulate matter, particularly in urban areas.

- Since 2000, much has been published on the pulmonary effects of particulate matter including the triggering of inflammation in the smaller airways, which can lead to the exacerbation of asthma and chronic bronchitis, airway obstruction and decreased gas exchange.
- Particulate matter can also interfere with the clearance and inactivation of bacteria in lung tissue.
- More recently, there has been a growing awareness that particulate matter is a cardiovascular risk factor that is associated with heart attacks, stroke, heart rhythm disturbances and sudden death.
- Effects of particulate matter that have experimental support for possible mechanisms are:
  - Inflammation.
  - Cytokine and chemokine release.
  - Production of white blood cells.
  - Oxygen free-radical production in the lungs.
  - Endotoxin-mediated cellular and tissue responses.
  - Stimulation of irritant receptors.
  - Covalent modification of key cellular enzymes.
- In humans, the effects of particulate matter on airway inflammation have been demonstrated.
  - Although there is still debate about which particle components are responsible for producing reactive oxygen species, there is accumulating evidence that pro-oxidative organic hydrocarbons, such as polycyclic aromatic hydrocarbons and quinines, and transition metals, such as copper, vanadium, chromium, nickel, cobalt, and iron, play a role.
  - These are associated with particulate matter in urban air that is typically the result of industry or vehicular emissions.
  - Some individuals may be more prone to the development of inflammation, asthma, and allergic responses, because of mutations in the genes involved in the induction of the antioxidant defense or due to old age, preexisting chronic heart and lung disease, and diabetes mellitus, all of which are associated with oxidative stress and inflammation.

5. OBJECTIVE 3: REVIEW OTHER SURVEILLANCE DATA.

a. "Deployment Health Surveillance Data Sources," Dr. Michael Kilpatrick (Appendix K)

(1) Dr. Kilpatrick, Office of the Assistant Secretary of Defense (Health Affairs) OASD(HA), provided an overview of DoD health surveillance programs.

- Troops are exposed to a great number of potential hazards that can be environmental or occupational in origin including particulate matter, chemicals, noise, infectious diseases and injuries.
- Health assessment opportunities present themselves throughout the service members' life cycle for both deployed and non-deployed (in garrison) settings. The current requirements for deployment-associated surveillance were listed in the pre-, intra-, and post-deployment phases. Deployment health surveillance consists of outbreak detection (health event surveillance), occupational health exposure surveillance, and environmental threat-based surveillance.
- Health surveillance in the theater of operations involves a complex system of data flows, analysis, and reporting patterns.
    - Among the most important data are the disease and non-battle injury (DNBI) weekly reports required by the Joint Chiefs of Staff.
    - The primary use of the DNBI reports is to identify outbreaks and monitor seasonal trends, but they represent broad disease categories and are limited in determining cause/effect relationships.

(2) Dr. Kilpatrick presented a list of future initiatives to enhance deployment health surveillance and concluded with some of the "best options" for enhanced health surveillance:

- Use Patient Encounter Module (PEM) and DNBI reports to monitor for acute disease outbreaks and adjust environmental sampling accordingly.
- Establish cohorts based on identified high risk sites and analyze health events, both in-theater and after redeployment home.
- Serum samples available for use with approved human subject research protocol. However, this repository was developed and intended for assessment of exposure to infectious agents; it has limited usefulness in chemical exposure. Consideration should be given for retaining the cellular component of the blood specimen obtained for this collection for potential biomarkers.

b. Discussion Following Dr. Kilpatrick's Presentation. When asked how the infectious disease rate in CENTCOM differs from the rates in previous campaigns, Dr. Kilpatrick stated that the rate is generally much lower compared with previous campaigns.

c. "Inhalation Injury: Pulmonary Pathology Analysis of Soldiers," Dr. Teri J. Franks (Appendix L)

(1) Dr. Franks gave an overview of the anatomy of the respiratory tract and discussed particulate deposition. She discussed various pathological conditions that can be seen at autopsy which demonstrate damage to the lung tissue. Patterns such as inflammation and fibrosis are multifactorial with a wide variety of causal agents that cannot be identified precisely without a complete history of potential exposures and other radiological and epidemiologic evidence.

(2) Smoking causes inflammatory changes and is a very significant factor in the development of lung disease. The effects of smoking and significant dust exposures can compromise the mucociliary mechanisms. In lungs with normally functioning mucociliary escalators, the flow of mucous is 3 mm/min, which is capable of clearing 80-90% of the inhaled materials in two hours. It is possible for these clearance mechanisms to be overwhelmed in situations such as dust storms.

(3) However, military lung disease occurrence generally does not appear to be significantly different from that of civilians. Exposure does not necessarily equal disease. It is also known that fibrotic disease may take years to develop.

d. "Dust Load in Autopsied Soldiers (Iraq 2003)," Dr. Val Vallyathan (Appendix M)

(1) Dr. Vallyathan presented histology photomicrographs of lung tissues from two autopsies of soldiers with pneumonia and four without pneumonia.

(2) Lung tissues were examined by NIOSH investigators using a scanning electron microscope equipped with back scattered imaging, and several particle inclusions in all cases were observed.

- Energy dispersive x-ray (XES) analysis of randomly selected particles identified several types of mineral particles, including pure crystalline silica, aluminum silicates with iron, pure iron, and iron with sulfur.
- In addition to the mineral inclusions, the lung tissues from all the cases contained small particle inclusions with characteristic size and birefringence similar to particles found in animals exposed to diesel.
    - The likely diesel particle inclusions observed in the lung tissues of these cases are distinguishable from cigarette smoke and other organic carbon by size and birefringence.
    - Cigarette smoke tar inclusions were identified with a NIOSH-developed fluorescent assay in these cases.

6. OBJECTIVE 4: PROVIDE CONSTRUCTIVE CRITICISM ON PROPOSED APPROACHES TO FILL DATA GAPS.

a. "Enhanced Surveillance Sub-Group, Particulate Matter Working Group," Dr. Jack M. Heller (Appendix N)

(1) Dr. Heller provided background information that explained the impetus for the enhanced environmental surveillance.

- The surveillance project has been funded by the U.S. Army Medical Command, and the scientific protocol is currently being finalized.
- Several other activities involving the procurement of equipment, contracting of analytical services, and Command authority support are also ongoing.

(2) The purpose of the project is to better define the characteristics of suspended particulate in the CENTCOM AOR.
- The protocol will include the collection of Total Suspended Particulates (~50 μm), PM_{10}, and $PM_{2.5}$ during 24 hour periods.
- Samples will be collected over the course of one year at 5-6 locations in Iraq, 2 locations in Kuwait, 2 locations in Afghanistan, 1 location in Qatar, and 1 location in the United Arab Emirates.
- The frequency of collection will be every sixth day, using various filters/analytical suites on a rotational basis every six days to accommodate the different types of analyses.
- The analyses are designed to characterize the chemistry and mineral types of the particles along with their aerodynamic mass distribution and morphology.

(3) Characterization of the PM microbial population will be more challenging.
- A stepwise process, beginning with the culturing of microbes from soil, will be used.
- Based upon the soil culture results, pathogenic and opportunistic species that are considered inhalation hazards will be targeted for air sampling to characterize risks.
- Sampling in the CENTCOM AOR is expected to commence by 15 October 2005.

b. Discussion Following Dr. Heller's Presentation.

(1) Given the biological importance of particle surface area, a NIOSH participant suggested that air sampling should include analysis for particle surface area as a function of aerodynamic particle size. Two techniques can be used. A diffusion charger provides real-time particle size analysis and requires very little particulate matter. The other technique was modified by Dr. Hoover of NIOSH is called nitrogen adsorption, which requires approximately 50 mg of fine and ultra fine particles.

(2) A participant questioned why mini-volumetric samplers were being used rather than high volumetric samplers, the most commonly accepted method of PM air pollution monitoring. Dr. Heller answered that the logistics and operation of high volumetric samplers by soldiers were impractical in the CENTCOM AOR under field or base camp conditions.

(3) A NIOSH participant expressed concern about the planned environmental sampling to assess the biological hazards of particulate matter. NIOSH has spent many years and resources characterizing airborne biological hazards in both indoor workplaces and in agricultural environments. In general, isolation and testing for individual microbial species has had limited value in assessing the biological hazards. NIOSH has found that testing for lipopolysaccharides (LPS) and beta-glucans was a more practical approach to assessing biological hazards from gram-negative bacteria and fungi, respectively.

(4) When asked if the study would compare the microbial sampling results with DNBI rates, Dr. Heller responded affirmatively. However, there are many challenges to the interpretation and analysis of microbial contaminants of air samples. It should be

recognized that sampling and analysis will evolve as an assessment of the biological component of air samples is developed.

(5) When asked if meteorological data would also be collected during the sampling periods, Dr. Heller stated that it would also be collected for later comparisons, including wind speed/direction and visibility measurements.

c. "Proposed Particulate Matter Toxicity Studies" LT Erin Wilfong (Appendix O)

(1) LT Wilfong started her presentation with a brief review of the literature and documented issues surrounding PM, particularly in the CENTCOM AOR.

(2) Her review also included toxicological research involving *in vivo* and *in vitro* methods. The purpose of LT Wilfong's proposed research is to determine if a single exposure to Iraqi PM (from sand) causes airway inflammation and injury.

- The samples to be used in the experiments came from sand/soil collected from Pad 15 in Iraq and were divided into fractions of PM_{10}, PM_{20}, and PM_{40}.
- Phase I of the research involves *in vitro* methods and will use lung and phagolysozyme simulant fluids to determine the rate at which different sized sand particles would release metals and other chemical constituents in the respiratory tract of humans. Samples will be removed from the dissolution system at various time points (1 hr.-14days) and assayed for metals and chemical constituents that may have leached off the particles.
- Phase II of the research involves *in vivo* methods using rats.
  - The purpose of this research is to assess acute airway injury/inflammation and metal and chemical constituent bioavailability following intranasal or intratracheal sand exposure.
  - To discern whether effects are due to sand and/or contaminants, rats will be exposed in groups to total sand, soluble sand, and insoluble sand.
  - The animals will be sacrificed at different time points (24 hours, 3 days, 7 days, 14 days, 3 months) and examined for inflammation, injury, and metal bioavailability.

d. Discussion Following LT Wilfong's Presentation.

(1) The most significant issue raised by the participants was the use of sand/soil to represent airborne PM. Based upon their experiences, NIOSH participants stressed that PM in soil or sand does not represent what is inhaled by individuals. LT Wilfong said she did not have PM collected from air samples, and she had a limited quantity of dust to use for the experiments. Furthermore, LT Wilfong was directed to complete the study within the next few months.

(2) Another concern was the absence of positive (Si) and negative (TiO_2) controls, or exposing animals to other particles with known characteristics for comparison purposes. The distinction between possible microbial and chemical responses by the animals was also a concern.

(3) The issue was raised that the current study design does not include full particle distribution characterization (mean, standard deviation). Aerodynamic sizing, not geometric sizing, is necessary for the characterization.

(4) The participants generally agreed that conducting the planned research hastily without all necessary materials and modified design would be counterproductive.

7. OBJECTIVE 5: IDENTIFY DATA NEEDS AND GAPS FOR CONDUCTING PARTICULATE MATTER HEALTH RISK ASSESSMENTS (HAZARD IDENTIFICATION, DOSE-RESPONSE, EXPOSURE ASSESSMENT, RISK CHARACTERIZATION).

a. Research Data Categories. The attendees reviewed four research data categories. A summary of the revised and weighted categories follows:

(1) Enhanced Surveillance (weight 3.3)

- Environmental Monitoring (personal & area).
- Sentinel Health Events.
- DNBI Surveillance
- Medical Surveillance (pre-, during, post-deployment) (cardiac, pre PFT)
- Pathology/Autopsy

(2) Studies and Analysis (weight 2.9)

- Toxicology Testing (*in vivo, in vitro*)
- Bioavailability
- Particulate Characterization (size, chemistry, microbiology)
- Quantitative Personal Sampling/Analysis
- Quantitative Ambient Sampling/Analysis
- Similar Exposure Grouping
- Epidemiologic Studies
  - Cross-Sectional
  - Cohort (prospective, retrospective, longitudinal)
  - Case-Control
  - Ecologic studies

(3) Basic Research (weight 2.3)

- Toxicology
- Particle/Aerosol Physics
- Aerobiology/Microbiology
- Geology
- Analytical Chemistry

(4) RDT&E (weight 1.4)

- Materiel, e.g., biomarkers

b. Data Gaps. In a round robin session, each attendee identified their number one data gap.

- Characterizing the particulate matter exposure in the area of operations (AO) as proposed by enhanced surveillance.
- Determining the particle surface area as a function of aerodynamic particle size.
- Determining the particulate matter exposure on the different conditions—truck driving vs. in camp vs. sandstorm.
- Determining the clinical conditions that arise from the exposure.
- Inadequate characterization of the exposure and the correlation to morbidity and mortality.
- Assessing the medical surveillance data (before and since they have returned).
- What are the health effects of particulate matter at the concentration and sizes in the area of operation?
- Pre- and post-deployment health evaluations (workup or physical instead of subjective questionnaire).
- Dose-response relationship to exposure and clinical manifestations.
- Better differentiation of DNBI data so associations can be made for primary diagnoses associated with respiratory health effects and ambient levels of particulate matter.
- Description of heath effects resulting from high-level particulate exposure.
- Characterizing the changes in the chemical, physical, biological and mineralogical properties of the particulate matter as a function of particle size.
- Pre- and post-deployment physical (what is being done is not adequate).
- Characterizing and anticipating the heath effects possible from the particulate matter.
- Assessing toxicity of the particulate matter for the various pathways of exposure and determining what standards or methods will be used to compare concentrations to health effect data.
- Elucidation of bioamplication of heavy metals (bioaccumulation in the particle) (the complexion of metals).
- Correlation of varying particulate matter exposure levels in the AO with DNBI in all plausible categories (e.g., cardiovascular effects).
- Relationships between the personal dose and the ambient measurement.
- Obtain an accurate smoking history.

c. Concerns. In another round robin session, each attendee identified his or her key concern or thought to be captured in the proceedings.

- Develop and implement interim personal protective measures for particulate matter as soon as possible (identified as concern by three attendees).
- Ensure that crystalline free silica exposure is recognized and controlled.
- Conduct pre- and post-health study of cohort deployed forces keying on measurement that would assess particulate matter exposure and follow cohort for several years thereafter.
- Quantitate the concentration of crystalline silica in ambient air exposure.
- Recognize cigarette smoking as a confounding/enabling factor.
- Disparate and unlinked data sets.

- Provide adequate communication of risk as we understand it to multiple parties (higher DoD, Veterans Affairs, soldier).
- Provide proper command attention to guidance from the Health Affairs community.
- Expand scientific role in the characterization of CENTCOM environment.
- Determine how data will be used and interpreted prior to any collection with input from various specialties.
- Use evidence-based approach to drive medical screening.
- Make a commitment to an epidemiological study of potential adverse health effects of particulate matter exposures in the AO.
- Define immediate and chronic effects of particulate matter exposure.
- Define the scientific basis for recommended interventions to reduce particulate matter exposures.
- Determine the impact of particulate matter exposures on force readiness.
- Provide adequate health education so that personal protection can be implemented.
- Use rigorous scientific approach to guide research.

8. OBJECTIVE 6: RECOMMEND A STRATEGY FOR PRESENTATION TO THE CHAIR, JOINT PARTICULATE MATTER WORK GROUP.

The chairs agreed to take the information from the workshop and package it for delivery to the Chair, Joint Particulate Matter Work Group.

9. NEXT STEPS

#	Tasks	Target Dates	Person(s) Responsible
1	Collate 1-1/2 days of presentations and discussions into draft proceedings.	By 15 October	Dr. Weese, Dr. Knechtges and Ms. Weyandt
2	Review draft proceedings.	Within 15 days of receipt of draft proceedings	All attendees
3	Forward final proceedings with recommendations to Health Affairs.	By 1 November	Dr. Weese and Dr. Knechtges
4	Provide feedback to Mark Brown, VA, who was not able to attend.	By 12 September	Dr. Weese
5	Post presentations and attendees roster to Web site.	By 12 September	Ms. Weyandt
6	Send evaluation forms to attendees for feedback.	By 9 September	Ms. Weyandt
7	Collate evaluation forms and present to Dr. Weese and Dr. Knechtges.	On receipt of all evaluation forms	Ms. Weyandt

Coleen Baird Weese, MD, MPH
USACHPPM

Paul L. Knechtges, Ph.D.
U.S. Army Center for Environmental Health Research

Dr. Vincent Castranova
NIOSH

Glossary of Acronyms

AFRL	Air Force Research Laboratory
AO	area of operations
AOR	area of responsibility
CENTCOM	U.S. Central Command
DNBI	disease and non-battle injury
DoD	Department of Defense
DQO	data quality objectives
EPA	Environmental Protection Agency
GAO	General Accounting Office
HELD	Health Effects Laboratory Division
LPS	lipopolysaccharides
MEG	Military Exposure Guideline
NAAQS	National Ambient Air Quality Standards
NIDBR	Naval Institute for Dental and Biomedical Research
NIOSH	National Institute for Occupational Safety and Health
OASD(HA)	Office of the Assistant Secretary of Defense (Health Affairs)
OEF	Operation Enduring Freedom
OEHS	Occupational and Environmental Health Surveillance
OIF	Operation Iraqi Freedom
PEM	Patient Encounter Module
PM	particulate matter
RDT&E	Research, Development, Testing, and Evaluation
SWA	shift weighted average
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAMRMC	U.S. Army Medical Research and Materiel Command
VOC	volatile organic compound
XES	energy dispersive x-ray